UNITED STATES PATENT APPLICATION

FOR

METHODS AND SYSTEMS FOR MANAGING ROUTING OF PACKETS OVER A HYBRID COMMUNICATION NETWORK

ON BEHALF OF

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TITLE OF THE INVENTION

METHODS AND SYSTEMS FOR MANAGING THE ROUTING OF PACKETS OVER A HYBRID COMMUNICATION NETWORK

FIELD OF THE INVENTION

The present invention relates generally to the field of managing the routing of packets over a hybrid communication network, operating both in circuit switched and packet switched modes, and, more particularly, to the methods and systems for managing the routing of packets through the hybrid network based on the destination telephone number.

BACKGROUND OF THE INVENTION

Traditional telephone service providers have been planning the transition to packet switched networks. In planning this transition, consideration must be given to providing POTS users, who only have analog equipment, access to such networks. Such a transition should also facilitate communication between fixed wireless subscribers and POTs subscribers. Additionally, consideration must be given to providing local subscribers with direct access to their packet network.

Therefore, there remains a need to provide POTs and wireless service subscribers with improved direct access to packet networks, and particularly, a need for improving communication between such subscribers.

SUMMARY OF THE INVENTION

The present invention overcomes the above, and other, limitations by providing communication methods and systems for routing packets, such as digitized voice, from a fixed wireless service subscriber to a destination over a hybrid network, operating in both circuit switched and packet switched modes.

In one aspect, the invention features a system for managing the routing of information from a source to a destination through a plurality of networks, wherein at least one of the networks is a packet network. The system comprises a routing processor for receiving a routing query signal from the source. The signal specifying the destination to which the information will be routed. The system also comprises a memory for storing at least one characteristic of the source and at least one characteristic of the destination. The processor of the system determines a route for the transmission of the information based on the routing query signal and on the characteristics stored in the memory.

In another aspect, the invention features a method for managing the routing of information to a destination through a plurality of networks, wherein at least one of the networks is a packet network and each network is linked to at least one other network by a communication medium. The method comprises the steps of:

1) receiving a routing query signal specifying a destination to which the information will be routed;

2) storing at least one characteristic of the destination; and

3) determining a route for the transmission of the information based on the routing query and on the stored characteristics.

In another aspect, the invention features a method for managing the routing information from a subscriber of a fixed wireless service network to a destination through a plurality of networks, wherein at least one of said networks is a packet network and wherein each network is linked to at least one other network by a communication medium. The method comprises the steps of:

1) receiving a routing query signal from the subscriber of the fixed wireless service network;

2) storing information concerning at least one characteristic of the destination at a routing processor;

3) determining a transmission path for routing the information through the networks, the transmission path comprising elements of at least one of the networks in addition to elements of the packet network, wherein the step of determining the transmission path is based on the routing query signal and the stored characteristics;

4) sending a routing response signal from the routing processor to the subscriber; and

5) routing the information over the path.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a block diagram illustrating a system for managing the routing of packets over a hybrid communication network in accordance with one embodiment of the present invention;

FIG. 2 is a block diagram illustrating an embodiment of a base station of FIG. 1.

FIG. 3 is a block diagram illustrating an embodiment of a remote unit of FIG. 1;

FIG. 4 is a functional block diagram of a method for setting up a call using the system of FIG. 1;

FIG. 5 is a functional subscriber block diagram of a method for determining a routing path to a PSTN subscriber destination and forwarding a call to said destination through such a path using the system of FIG. 1;

FIG. 6 is a functional block diagram of a method for determining a routing path to a fixed wireless subscriber destination and forwarding a call to said destination through such a path using the system of FIG. 1;

DESCRIPTION OF THE PREFERRED EMBODIMENTS

The present invention relates to routing packets of, for example, digitized voice, from a subscriber of fixed wireless services to a subscriber at a

destination through a hybrid network. The subscriber at the destination being either a subscriber of fixed wireless services or POTS services.

FIG. 1 shows a simplified hybrid communication network **10** suitable for use in accordance with an embodiment of the present invention. It will be recognized that the network of FIG. 1 includes other known elements, but those elements have been omitted for simplicity.

Referring to FIG. 1, network **10** comprises at least one calling party location, such as location **30**, at least one information transfer network, such as fixed wireless network **10a**, Public Switched Telephone Network (PSTN) **10b** or data network **10c** (i.e. ATM based backbone) and at least one destination party location, such as locations **20** and **40**. Destination location **20**, subscribes to PSTN **10b** and destination location **40** subscribes to network **10a**.

A wired information transfer network, such as PSTN **10b**, generally comprises a plurality of conventional switches (not shown) that are interconnected to enable wired device **20** to communicate with other devices within or outside PSTN **10b** via LEC **50**. The wired device may be a conventional telephone **20**, as illustrated in FIG. 1, or any other communication device (not shown) connected to PSTN **10b** by various communications links **23a** (e.g., analog, ISDN, etc). For example, wired device **20** could include facsimile devices, personal computers, modems, etc.

Data network **10c** includes a packet switched network, comprising, preferably, an Asynchronous Transfer Mode (ATM) subnetwork using protocols such as TCP/IP, X.25, ATM, etc. A data network such as network **10c**, generally comprises a plurality of packet routers for transmitting packets of data. The packets include address headers, error correction bits, synchronization bits and the like. It is understood that the present invention may be applied to any type of data packet subnetwork using the structures and methods described herein and is not limited to ATM subnetworks.

Referring to FIG.1, there is shown a simplified block diagram of a wireless communication network **10a** forming part of a hybrid network **10**, its logical entities as well as its relative connection to PSTN **10b** and data network **10c**. In the following description, the wireless communication network **10a** is described in the context of a fixed wireless subscriber's telephone, such as device **30**. It will, however, be understood that the methods and systems of the present invention can be applied to other wired or wireless modem communication systems such as laptop computers and fax devices.

Wireless communication network **10a**, as illustrated in FIG. 1, comprises a fixed wireless subscriber's telephone, such as devices **30** and **40**, remote units (RUs) **80** and **120**, and base stations (BSs) **70** and **110**. Typically, remote units

80 and **120** and base stations **70** and **110** each include a microprocessor (not shown) to control operations thereof.

Base stations **70** and **110** and remote units **80** and **120** each have a transceiver. Such transceivers include any modulation/demodulation, filtering, and other signal processing circuitry required for communicating in accordance with protocol and modulation techniques supported by the wireless systems.

Further, remote unit **80** is connected to device **30** by communication path **23a** and base station **70** is connected to remote unit **80** by airlink channel **23b**. Similarly, remote unit **120** is connected to device **40** by a communication path **23a** and base station **110** is connected to remote unit **120** by airlink channel **23b**. Communication path **23a** may be any number of wire-line transport services such as analog, ISDN, T1 or E1 line, or any of a number of other wireless alternative links. Airlink channel **23b** may be any wireless highway of fixed bandwidth that is used to transfer data between remote units **80** and **120** and base stations **70** and **110**, respectively, at fixed speeds. Devices **30** and **40**, remote units **80** and **120**, and base stations **70** and **110** use airlink channel **23b** and communication path **23a** to set up the call and to forward the voice or data to the destination device; the destination device being either a wireless device **40** or wired telephone **20**. Throughout the communication process, it is base station **70** that provides overall control and thereby ensures that the operation of the whole wireless system is supported and serviced.

In operation, base stations **70** and **110** couple devices **30** and **40** to (PSTN) **10b** or data network **10c**. As illustrated in FIG. 1, such coupling occurs through communication paths **23a**, access nodes **90** and **100**, Gateway **130** and switching units **60** and **140**. As indicated above, communication paths **23a** may be any number of wire-line transport services such as analog, ISDN, T1 or E1 line, or any one of a number of other wireless alternative links. Access nodes **90** and **100** perform all the switching functions related to call delivery through data network **10c**. Nodes **90** and **100** are connected to data network **10c**, Gateway **130**, and base stations **70** and **110**. Switches **60** and **140** perform all the switching functions related to call delivery through PSTN **10b**. Switch **60** is connected between PSTN **10b** and base station **70** and switch **140** is connected between PSTN **10b** and base station **110**. Switch **140** is also connected between PSTN **10b** and Gateway **130**. As is known in the art, switching units **60** and **140** typically consist of class 4/5 programmable digital switch with CCIS communications capabilities. Switching units **60** and **140**, can be for example, a 5ESS switch manufactured by AT&T or any comparable digital switch made by other vendors, such as Northern TeleCom and Seimans.

Gateway **130** includes a database and process unit (not shown). The database in Gateway **130** maintains an inventory profile of routings to fixed wireless network **10a** and PSTN **10b**, all switching units (e.g., switching units **60** and **140**) and all access nodes (e.g., access nodes **90** and **100**). The database is used by Gateway

130 to determine a routing path to a fixed wireless subscriber, such as device **30**, when a call is originated from an analog telephone (POTS) user, such as telephone **20** to device **30**. Gateway **130** also uses the database to determine a routing path from an access node, such as node **90**, to a PSTN **10b** subscriber, such as telephone **20**, when a call is originated from a fixed wireless subscriber telephone, such as device **30**, to an analog telephone (POTS) user telephone, such as telephone **20**.

Database may include storage devices such as random access memory (RAM), read only memory (ROM) and/or programmable read only memory (PROM), an erasable programmable read-only memory (EPROM), an electronically erasable programmable read-only memory (EEPROM), a magnetic storage media (i.e., magnetic disks), or an optical storage media (i.e., CD-ROM), and such memory devices may also be incorporated into a processing unit. Processing unit (not shown) includes software and hardware used by Gateway **130** to perform internetworking functions, such as packetization and depacketization, between a fixed wireless subscriber, such as device **30**, and a POTS user, such as telephone **20**.

Shown in FIG. 2 is a high-level block diagram of a base station FIG. 1 in accordance with the invention. Design and operation of such base stations are well known to ordinarily skilled artisans, and the ensuing description sets forth merely by way of example certain functional blocks and their interconnection as may be

embodied in a base station which may be used in accordance with the present invention.

The following discussion will focus on base station **70**, although base station **110** contains a similar database. Base station **70** includes a database **24** and processing unit **25**. The database **24** in base station **70** maintains an inventory profile record of all subscribers to the wireless service, identification numbers associated with other types of calls (e.g., calls to subscribers of PSTN **10b**) and call routing information for all base stations in wireless service network **10a**. Database **24** may include storage devices such as random access memory (RAM), read only memory (ROM) and/or programmable read only memory (PROM), an erasable programmable read-only memory (EPROM), an electronically erasable programmable read-only memory (EEPROM), a magnetic storage media (i.e., magnetic disks), or an optical storage media (i.e., CD-ROM), and such memory devices may also be incorporated into processing unit **25**.

Processing unit **25** in base station **70** includes software used by base station **70** to perform the communications processing and control functions between base station **70** and fixed wireless subscriber devices, such as device **30**, as well as all other control functions that are required for managing a call from such a device to a destination. For example, preferably, the software is used to determine a routing path

based on the called party identification number (i.e. fixed wireless subscriber telephone or PSTN subscriber telephone).

Shown in FIG. 3 is a high-level block diagram of remote units **80** and **120** in accordance with the invention. Design and operation of such remote units are well known to ordinarily skilled artisans, and the ensuing description sets forth merely by way of example certain functional blocks and their interconnection as may be embodied in a remote unit which may be used in accordance with the present invention.

For simplicity, remote unit **80** will be described. It is understood, however, that remote unit **120** is similar to remote unit **80**. Although remote units **80** may communicate with base station **70** according to known analog communication techniques, preferably remote unit **80** employs digital communication techniques. Remote unit **80** comprises a network interface **26**, an adaptor **27** used for DTMF digit collection, DTMF decoder/generator **28** and a speech coding module **33**. Remote units **80** also includes a D/A converter **29** to perform conversion of digitally sampled speech signals to analog speech signals and an A/D converter **30** to perform conversion of analog speech signals to digitally sampled speech signals. Further, remote unit **80** contains a central processing unit **31** and memory unit **32**.

The overall function of remote unit **80** is controlled by central processing unit **31**. Central processing unit **31** operates under control of executed

computer program instructions which are stored in memory unit **32**. Memory unit **32** may be any type of machine readable storage device. For example, memory unit **32** may be a random access memory (RAM), a read-only memory (ROM) and/or a programmable read-only memory (PROM), an erasable programmable read-only memory (EPROM), an electronically erasable programmable read-only memory (EEPROM), a magnetic storage media (i.e., magnetic disks), or an optical storage media (i.e., CD-ROM). Further, remote unit **80** may contain various combinations of machine readable storage devices which are accessible by central process unit **31** and which are capable of storing a combination of computer programs, instructions and data.

The telephone network interface module **26** handles the interaction between remote unit **80** and fixed wireless subscriber's telephone, such as device **30**. Interface module **26** also handles the interaction between remote unit **80** and base stations, such as base station **70**.

DTMF decoder/operator **28** converts DTMF tones into digital data. Speech coding module **33** performs compression and decompression of speech signals connecting at, for example, fixed wireless subscriber's telephone, such as device **30**, and received over communication path **23a**. Such speech signals are processed and converted into digital data by speech coding module **33**. Preferred low-rate digital voice coding (less than 16 Kbps) is used. The functionality of module **33** may be

implemented in hardware, software or a combination of hardware and software, using well-known signal processing techniques.

Remote unit **80** also perform functions such as switch-hook operations, hybrid, ring detect, line termination, on/off hook signal interface signals and the like.

Referring to FIG. 4, there is illustrated an operational flow chart of how an embodiment of the present invention proceeds to set up a call in accordance with the system represented by FIG. 1. Referring now to Figure 4, there is shown a flow diagram for a process executed by base station **70** in response to a call set up query placed by fixed wireless subscriber device **30** via remote unit **80**. Specifically, when a call is placed by device **30**, an off-hook signal is sent through communications path **23a** to the transceiver of remote unit **80** (step **400**). Remote unit **80** then sends a dial tone to device **30** indicating that it is ready to receive the called party's telephone number (step **401**). Device **30** then sends DTMF signals to the transceiver of remote unit **80** via path **23a** (step **402**). The DTMF signals represent the call set up query and include the identification number corresponding to the destination. Remote unit **80** then sends a hold transmission message to device **30** (step **403**) and remote unit **80** forwards the call set up query to the transceiver of base station **70** via airlink channel **23b** (step **404**).

Base station **70** performs a database **24** look-up to identify the calling subscriber (step **405**). Once the base station **70** processes the calling party features, it

may perform any calling party based treatment (e.g., call blocking, reverse billing, etc.). Base station **70** then identifies the destination identification number, held in packet payload, and determines the subscriber service associated with the destination identification number (step **405**).

Specifically, base station **70** looks in database **24** to determine whether the destination identification number corresponds to a wireless subscriber, such as device **40**, or a PSTN subscriber, such as device **20** (step **406**). Once base station **70** identifies the destination, base station **70** determines a routing path from device **30** to the destination based on base station's **70** knowledge of the network topology (step **407**).

Referring now to FIG. 5, an operational flow diagram is illustrated for the process executed by base station **70** in determining a routing path (step **407**) based on a fixed wireless subscriber originated call (e.g., originating from device **30** of FIG. 1) placed to the destination number of a PSTN **10b** subscriber (e.g. wired telephone **20** of FIG. 1).

Base station **70** sends a routing query signal to Gateway **130** through access node **90**, data network **10c** and access node **100**, respectively (step **408**). Gateway **130** checks its database and determines a routing path from access node **100** to PSTN **10b** subscriber device **20** through switching unit **140** and LEC **50**, respectively. Gateway **130** then sends the routing path information to base station **70**

through access node **100**, data network **10c** and access node **90**, respectively (step **409**). Base station **70** then reserves the routing path by sending a reservation signal to Gateway **130** and Gateway **130** reserves the elements on the routing path (step **410**). Once the network elements are reserved a reservation acknowledgement signal is sent from Gateway **130** to base station **70**, via access node **100**, data network **10c** and access node **90**, respectively (step **411**). Base station **70** then sends a routing path signal to device **30** via remote unit **80** (step **412**).

The routing path signal includes a signal informing remote unit **80** to turn transmission on and start transmitting the information. Device **30** sends voice information to remote unit **80**, via communication path **23b** (step **413**), and remote unit **80**, then digitizes and compresses such information (step **414**). Remote unit **80** then forwards this digitized information to base station **70**, via airlink channel **23b** (step **415**) and base station **70** packetizes the information and forwards it to Gateway **130** through access node **90**, data network **10c** and access node **100**, respectively (step **416**). Gateway **130** depacketizes such voice information and forwards it to device **20**, through switching unit **140** and LEC **50**, respectively (step **417**).

An alternative method for routing a call to a PSTN **10b** subscriber device **20** is through the standard circuit switched network without packetization. Specifically, a call is forwarded from base station **70** to device **20** through switching unit **60**, PSTN **10b** and LEC **50**, respectively.

Referring now to FIG. 6, an operational flow diagram is illustrated for the process executed by base station **70** in determining a routing path (step **407**) based on a fixed wireless subscriber originated call (e.g., originating from device **30** of FIG. 1) placed to the destination number of another fixed wireless subscriber (e.g., device **40** of FIG. 1). Base station **70** performs database **24** look-up and determines a routing path to destination device **40** (step **418**). Base station **70** then reserves the path by sending reservation signals to base station **110** through access node **90**, data network **10c**, and access node **100**, respectively (step **419**). Base station **110** reserves the network elements on routing path (step **420**). Once the network elements on the path are reserved, base station **110** sends acknowledgement signals to base station **70**, via access node **100**, data network **10c**, access node **90**, respectively (step **421**). Base station **70** then sends a routing path signal to device **30** via remote unit **80**, respectively (step **422**).

The routing path signal includes a signal informing remote unit **80** to signal device **30** to turn transmission on and start transmitting the information. Device **30** then sends voice information to remote unit **80**, via communication path **23b** (step **423**), and remote unit **80**, then digitizes and compresses such information (step **424**). Remote unit **80** then forwards this digitized information to base station **70**, via airlink channel **23b** (step **425**), and base station **70** packetizes the information and forwards it to wired device **40** through access node **90**, data network **10c**, access node **100** and

base station **110**, respectively (step **426**). Base station **110** depacketizes such voice information and forwards it to device **40** via remote unit **120** (step 430).

Although the above description provides many specificities, these enabling details should not be construed as limiting the scope of the invention, and it will be readily understood by those persons skilled in the art that the present invention is susceptible to many modifications, adaptations, and equivalent implementations without departing from this scope and without diminishing its attendant advantages. It is therefore intended that the present invention is not limited to the disclosed embodiments but should be defined in accordance with the claims which follow.